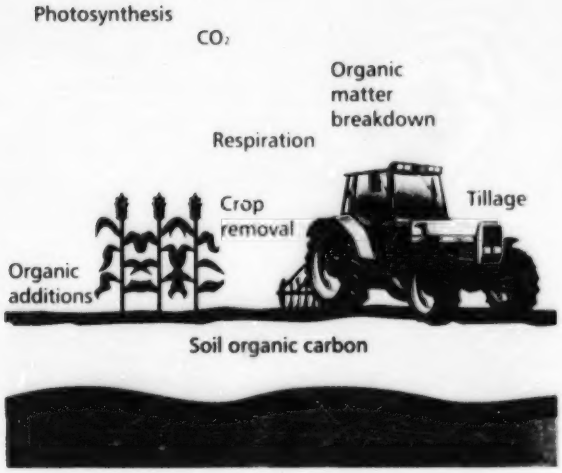
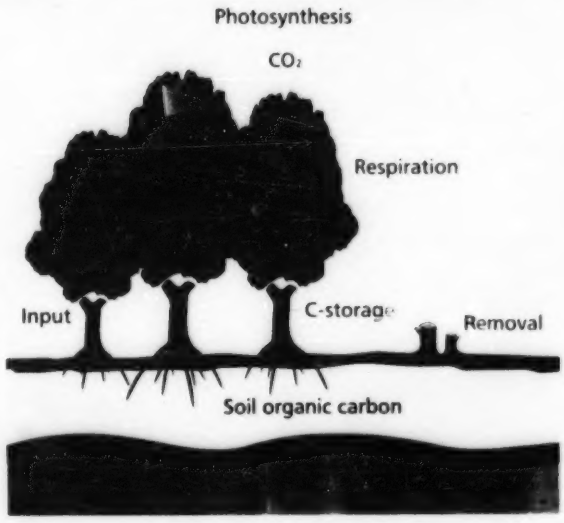
INFOSHEET # 2

Carbon Sequestration and Ontario Agriculture

Ontario

The Carbon Cycle





Agriculture is well-positioned to combat the production of greenhouse gases (GHGs). Efforts by Ontario farmers to increase crop yields, manage crop residues, improve cropland soil organic matter levels, and grow more trees will help remove carbon dioxide ($C0_2$) from the atmosphere. This in turn will offset the release of GHGs from other sources.

But before we explore the most effective on-farm best management practices for reducing GHG levels, here are some basic principles of GHGs and the carbon cycle.

GHGs are natural and human-generated gases that insulate the Earth's atmosphere and contribute to global warming and climate change. The GHGs of most concern are nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2).

Agriculture is both a **source** of atmospheric CO_2 gas and a **sink** to help remove it.

Agriculture is a source when pasture, wetlands and woodlands are cleared and converted to cropland – enormous levels of soil organic carbon (SOC) are lost to the atmosphere as CO_2 gas. More SOC is lost by normal tillage practices when they are not offset by rotations with forages, cover crops or manure additions.

Agriculture can be a sink by sequestering carbon. Crops and trees use the process of photosynthesis whereby sunlight is used to convert CO_2 into plant material. This plant matter may be removed from the site, used as food, remain as stable plant material (e.g., wood, corn stalks), or decompose to become part of the soil organic matter.

The removal of atmospheric CO_2 gas by plants and its transformation to crop tissue, wood materials in trees and soil organic matter is known as **carbon sequestration**. In turn, carbon sequestration results in higher levels of SOC, which is the level of carbon in the organic matter (humus + decomposing crop residues) of agricultural soils.

This continual transformation of carbon from gas to plants to soil is part of the **carbon cycle**.

To help lower GHGs from agriculture, farmers should strive to:

- **maintain SOC** – keep what's there with soil conservation practices and increase SOC levels by adding plant material, residue and manure
- **keep carbon in storage longer** – plant trees as windbreaks and buffers, and on fragile lands
- **reduce fossil fuels** – use farm-grown fuels such as ethanol from grain or methane from manure as alternatives

GLOSSARY

BMP	best management practice		
C	carbon	**N**	nitrogen
CH_4	methane	**N_2O**	nitrous oxide
$C0_2$	carbon dioxide	**$N0_3$**	nitrate
GHGs	greenhouse gases	**SOC**	soil organic carbon

One strategy for reducing the higher levels of CO_2 in the atmosphere is to increase carbon sequestration. In other words, we need to store more than we lose. When SOC gains exceed losses through management practices, a net increase is realized.

Soil and crops

The process of reducing SOC loss and adding carbon to soil through cropping practices is slow. The good news is that best management practices that do this have many other benefits such as improved soil health and reduced erosion.

Trees and crops act as "sinks" by storing carbon.

Compared to conventional tillage systems, **no-till:**

- reduces the loss of SOC
- increases SOC levels, and
- requires less fossil fuels.

FACTORS AFFECTING THE BALANCE OF SOC GAINS & LOSSES

SOC GAINS	SOC LOSSES
• cover crops and green manures	• soil loss – water, wind and tillage erosion
• conservation tillage	• intensive tillage
• residue management	• whole plant harvest
• high yields (more residue)	• low yields (less residue)

BEST MANAGEMENT PRACTICES FOR SOIL & CROPS

BEST MANAGEMENT PRACTICE	CARBON SEQUESTRATION POTENTIAL (per ha basis)	ADDITIONAL GHG BENEFITS	SOIL, WATER & OTHER ENVIRONMENTAL BENEFITS
NO-TILL	• medium	• reduces amount of fossil fuels that are burned • could decrease N_2O release by improving spring drainage	• minimizes erosion and runoff • improves soil quality
OTHER CONSERVATION TILLAGE (reduced tillage)	• low	• reduces amount of fossil fuels that are burned	• minimizes erosion and runoff • improves soil quality
APPROPRIATE USE OF MANURES & OTHER ORGANIC MATERIALS (e.g., spring application, rates)	• medium	• lessens need for additional commercial nitrogen fertilizers • may lessen available N for N_2O release	• improves soil quality • can reduce nitrate leaching
PASTURE MANAGEMENT (permanent & improved)	• medium	• decreases N loss to atmosphere, assuming less fertilizer is added	• improves soil quality • minimizes erosion
CROP ROTATION	• low	• maximizes yield (more residue) • lowers need for additional N fertilizers if legumes are included in rotation	• reduces disease and weed pressures • improves soil quality
WINTER COVER CROP	• low	• by trapping available N, leaching and N_2O emissions are reduced (if left live over winter and killed in spring)	• minimizes erosion • improves soil quality

Although **cover crops** have half the C storage potential of no-till, they perform an important role. When they're left live over winter and killed in spring, cover crops help minimize N_2O emissions.

Crop rotations not only improve crop yields and soil quality, they also help reduce GHG production by reducing the need for additional nitrogen fertilizers.

Application of **animal manures** can substantially increase soil organic carbon levels.

Farm forestry

Trees and woodlots have a high potential for carbon sequestration. Carbon is stored for the life of the tree (and the life of the wood product thereafter). Without the disturbance of tillage, forest soils either gain carbon or are net neutral. Mature trees – 50 to 150 years, depending on the species – are more effective at carbon sequestration than young or over-mature trees.

There are many opportunities to increase the number of trees on farmland. Tree plantings are most beneficial when planned and managed properly.

BEST MANAGEMENT PRACTICES FOR FARM FORESTRY

BEST MANAGEMENT PRACTICE	CARBON SEQUESTRATION POTENTIAL (per ha basis)	ADDITIONAL GHG BENEFITS	SOIL, WATER & OTHER ENVIRONMENTAL BENEFITS
WOODLANDS & REFORESTED AREAS	• high	• releases less N_2O because woodlands are not fertilized	• eliminates erosion • provides wildlife habitat • protects groundwater recharge areas
RIPARIAN BUFFER STRIPS, WINDBREAKS & SHELTERBELTS	• medium	• removes leached NO_3, which could lead to N_2O production	• minimizes erosion and siltation of streams • traps and utilizes nutrients • improves aquatic habitat • provides a wildlife corridor
INTERCROPPING	• medium	• removes NO_3 in soil water • takes land out of cultivation and reduces need for fertilization • reduces loss of SOC and N_2O from cropped fragile land	• increases biodiversity • creates wildlife habitat • reduces wind erosion • provides wind protection for crops

Carbon sequestration in woodlands and reforested areas is maximized when the **forest is managed** through thinning.

Field windbreaks and shelterbelts reduce nutrient and soil movement and sequester carbon in wood and soil. Shelterbelts around farm buildings significantly reduce the fossil fuel requirements for heating, cooling and snow removal.

Trees in riparian zones remove NO_3 in groundwater and trap sediment before it reaches watercourses. They also sequester carbon and generally improve aquatic habitat.

Opportunities & Challenges

Through province-wide adoption of BMPs, Ontario agriculture has the potential to sequester six million tonnes of carbon dioxide equivalents by 2012. This would mark a substantial cut in Ontario's GHG emissions. It may also present an opportunity to the province's farmers, who could benefit financially from a carbon emission trading system.

The Basics of Emissions (or Carbon) Trading

Manufacturing and energy sectors emit GHGs, and cost-effective approaches to reducing emissions are limited in the short term. At the same time, the agriculture sector has identified BMPs that can lower on-farm emissions (such as improved nutrient management) and sequester carbon (such as no-till).

In an emissions trading system, the commodity for trade is carbon-dioxide equivalents (or carbon credits). The trade is based on the principle that industries would be willing to pay farmers to adopt GHG-friendly BMPs. In other words, farmers could get paid for changing their practices, and industries could meet their targets for GHG emission reduction.

The prospect of carbon trading raises several issues:

- **practicality** – GHG-reducing BMPs must be feasible, and not cause undue disruption (e.g., taking a large number of operable acres out of production to plant windbreaks, buffers etc.)
- **profitability** – the incentives offered to farmers must be sufficient to pay for many of the on-farm changes
- **societal assurance** – society at large would need assurance that this short-term "fix" doesn't become a permanent solution for industrial emitters
- **research** – more research is needed to conclusively predict SOC additions that result from specific soil BMPs.

As more research is completed, responsibility will fall to farmers to make full use of those findings and make GHG reduction a reality. Farmers will have to take a full inventory — determining all sources of GHG emissions and potential sinks — and select those BMPs that will profit both the environment and their businesses in the long term.

Other areas in need of study include:

- monitoring the effectiveness of carbon sequestering
- establishing a detailed soil carbon baseline database
- developing a sound measurement, monitoring and verification program that will satisfy international criteria and those of investors wishing to purchase carbon credits
- determining the potential of tree species and management practices to sequester carbon
- identifying the balance between methane and carbon dioxide production in natural and managed areas.

Where to go for more information

Key web sites

Your link to OMAFRA's Climate Change resources:
http://www.gov.on.ca/OMAFRA/english/policy/Climate%20Change/Index.html

Web site for National Climate Change Process. Available documents include: "Canada's First National Climate Change Business Plan," and "Ontario – Air Quality and Climate Change: Insights, Opportunities and Solutions." http://www.nccp.ca

Multimedia overviews of climate change, and links to GHG calculators: http://www.climatechange.gc.ca

For farmers and rural landowners

The Best Management Practices series of books, including: *Farm Forestry and Habitat Management, Field Crop Production, No-till: Making it Work, Nutrient Management* and *Soil Management*
– available by calling 1-888-4-OMAFRA (1-888-466-2372) or e-mail your request to products@omafra.gov.on.ca or visit OMAFRA's web site at www.gov.on.ca/omafra

Technical reports

Boehm, M. et al. "Sink Potential of Carbon Sequestering Agricultural Activities." Agriculture and Agri-Food Canada, 2000

Jacques Whitford Environment Limited. "Ontario's Challenges and Opportunities in Soil Carbon Sequestration Under the Kyoto Protocol." Final Report to OMAFRA, 2000

Watson, Robert T. et al (eds.). "Land Use, Land-Use Change, and Forestry – Special Report of the Intergovernmental Panel on Climate Change." Cambridge University Press, 2000

Funding for this series of Greenhouse Gas infosheets has been provided by the Ontario Climate Change Fund.

The Greenhouse Gas infosheets are a project of the Ministry of Agriculture, Food and Rural Affairs.

For more information, call the Ministry of Agriculture, Food and Rural Affairs, Agricultural Information Contact Centre at 1-877-424-1300, or e-mail: ag.info@omafra.gov.on.ca

This is the second of a four-part series that addresses greenhouse gas emissions and their implications for Ontario farmers. Infosheets #1, #3 and #4 address respectively:

1. **greenhouse gases – what they are, and what challenges and opportunities lie ahead for Ontario farmers**
3. **nutrient management – how good planning can reduce emissions**
4. **on-farm case studies.**

All four infosheets will be available by spring 2001 at select locations, and accessible through the Ministry of Agriculture, Food and Rural Affairs web site at:
www.gov.on.ca/OMAFRA/english/policy/Climate%20Change/Index.html

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